Connecting GPM data to Decision Makers: Applications and Outreach

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GPM's Applications Strategy

User Engagement

Knowledge Sharing

- Visualizations and videos
- Outreach Materials
- Stories
- Training
- Webinars

Engagement and User Outreach

Synthesizing Information from Community

- Workshops and conferences
- Discussions
- Data analysis of users

DATA

NASA

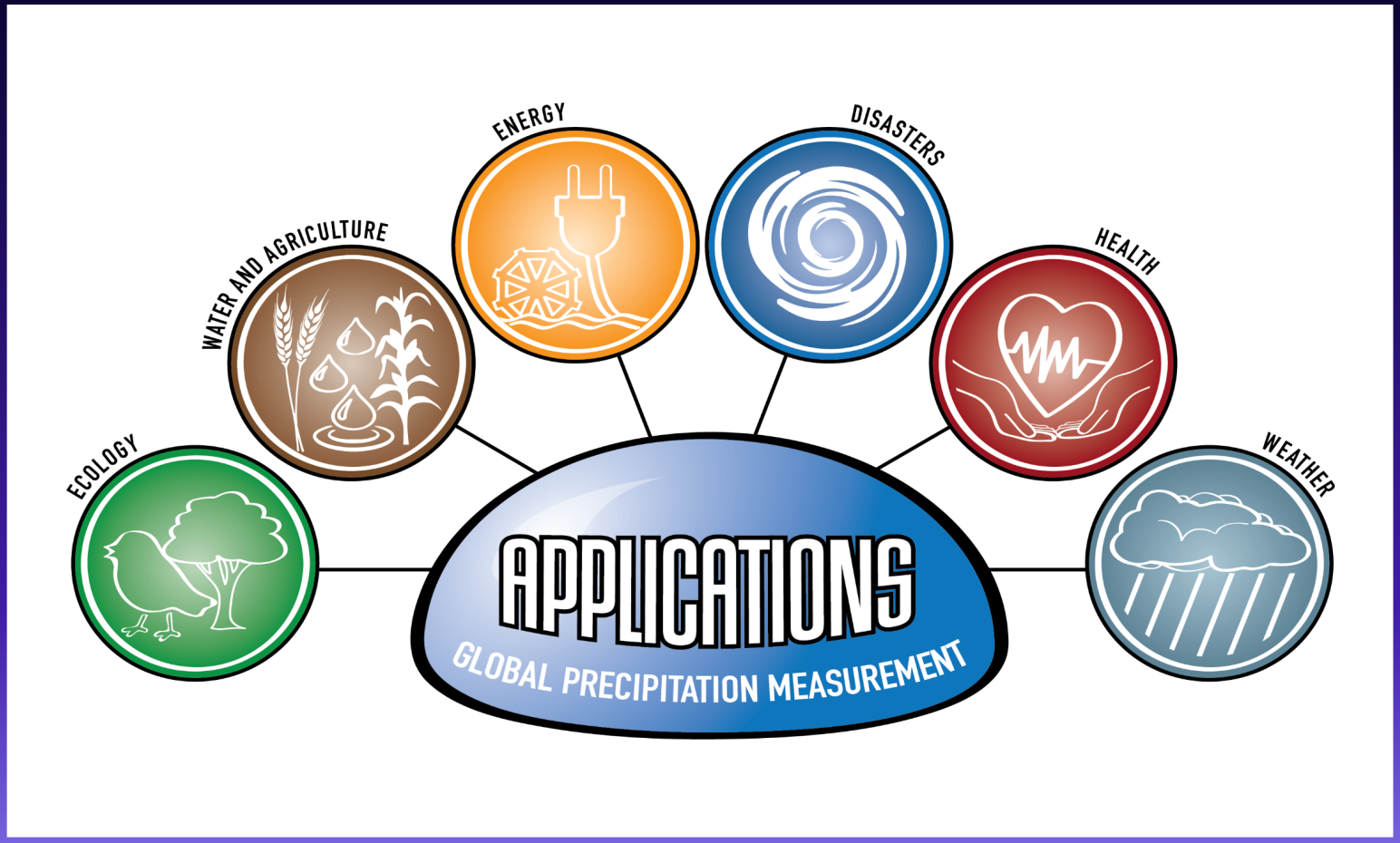
Decision Making

- Case Studies
- Data requirements and needs
- Challenges and gaps
- Capacity building- new avenues of research

Informal Partnerships and Collaborations

- WRI
- MiCRO
- World Bank
- USDA
- Agvesto
- PDC

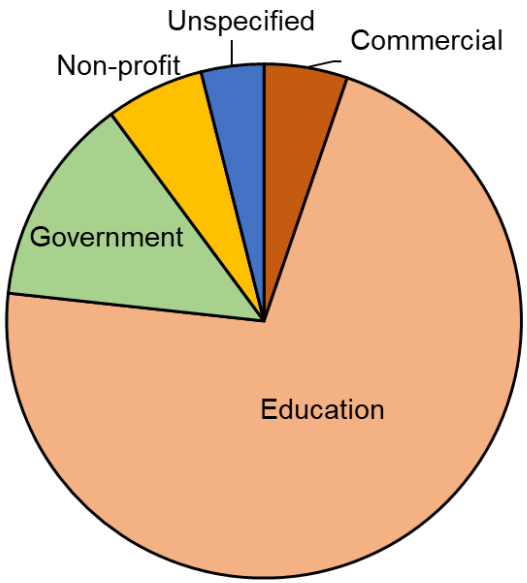
GPM Applications Areas



GPM Applications Portfolio

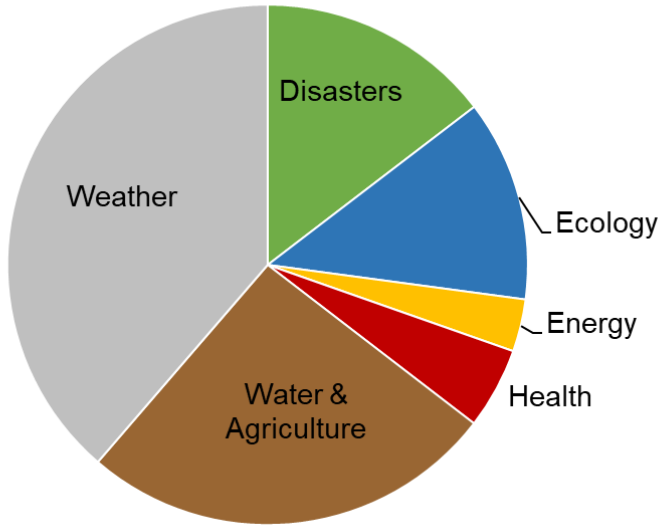
GLOBAL PRECIPITATION MEASUREMENT

GPM Data Users by Sector



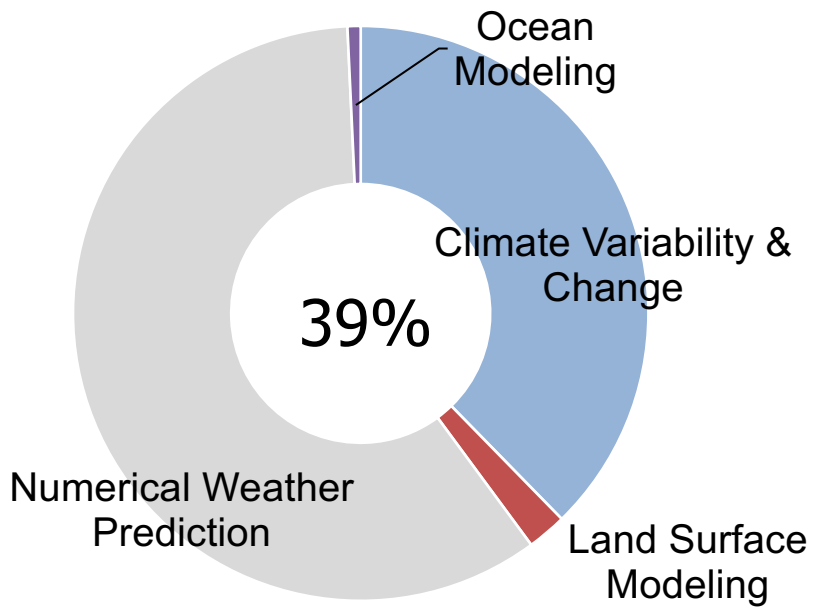
Goal is to better understand the user community and reach into sectors that may not be well represented or better engage active groups

GPM User by Application Area



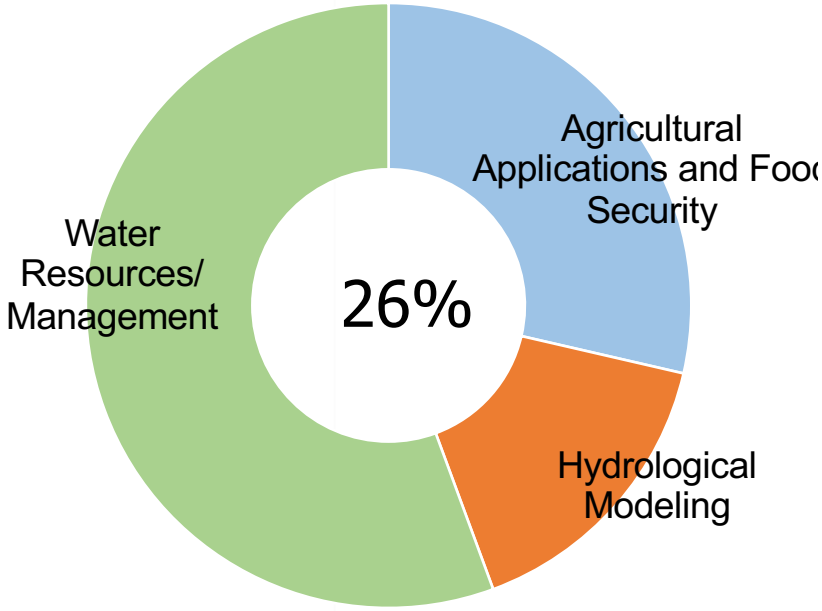
- On average ~1,000 unique users per month access GPM data and products (GDISC and PPS)
- E-mail, type of user, application area

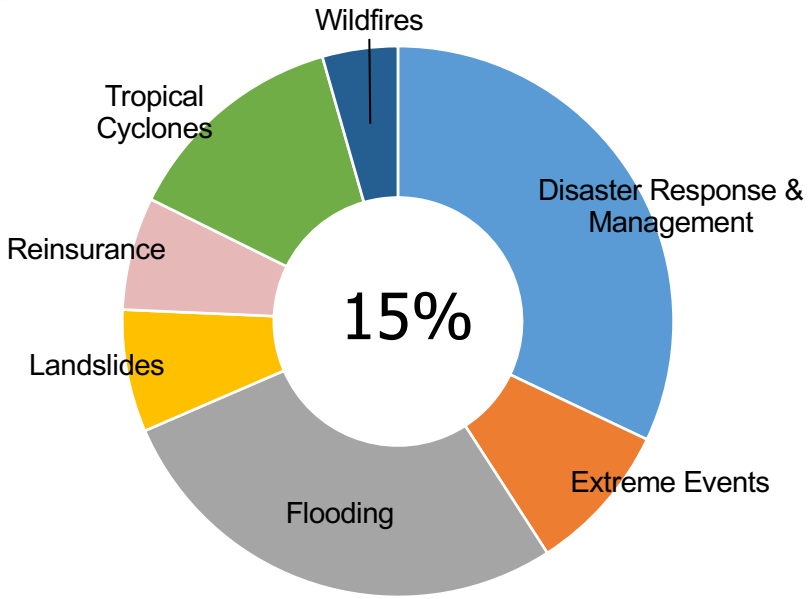
Over 85 highlights have been made to show how GPM is being used for applications



Weather, Climate, Modeling

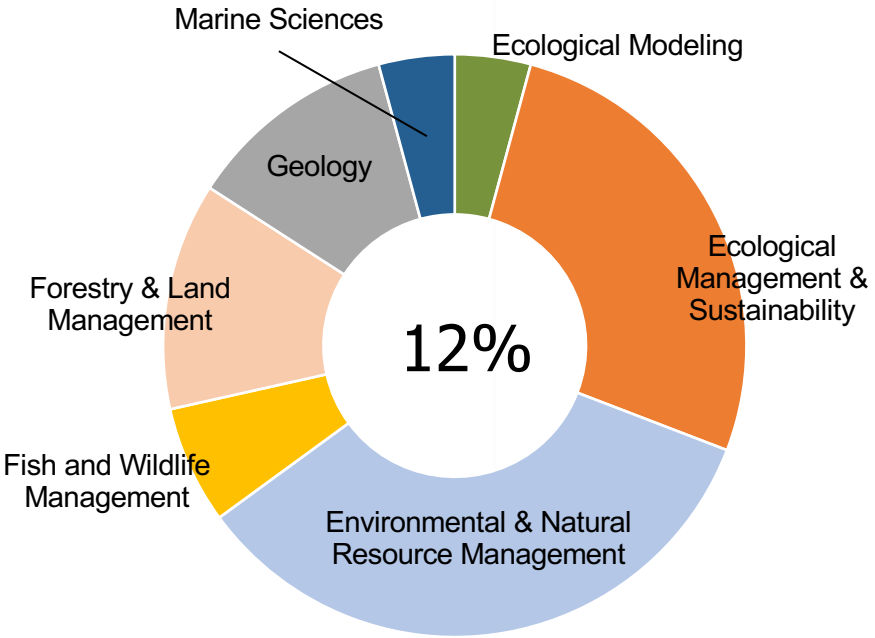
Water Resources, Agriculture, and Food Security





Disasters & Risk Management

Ecological Management



GPM Applications Examples

For all Applications Highlights please visit https://pmm.nasa.gov

To share an application with the GPM Team, please contact Andrea Portier!

Looking Inside Tropical Storm Lorenzo

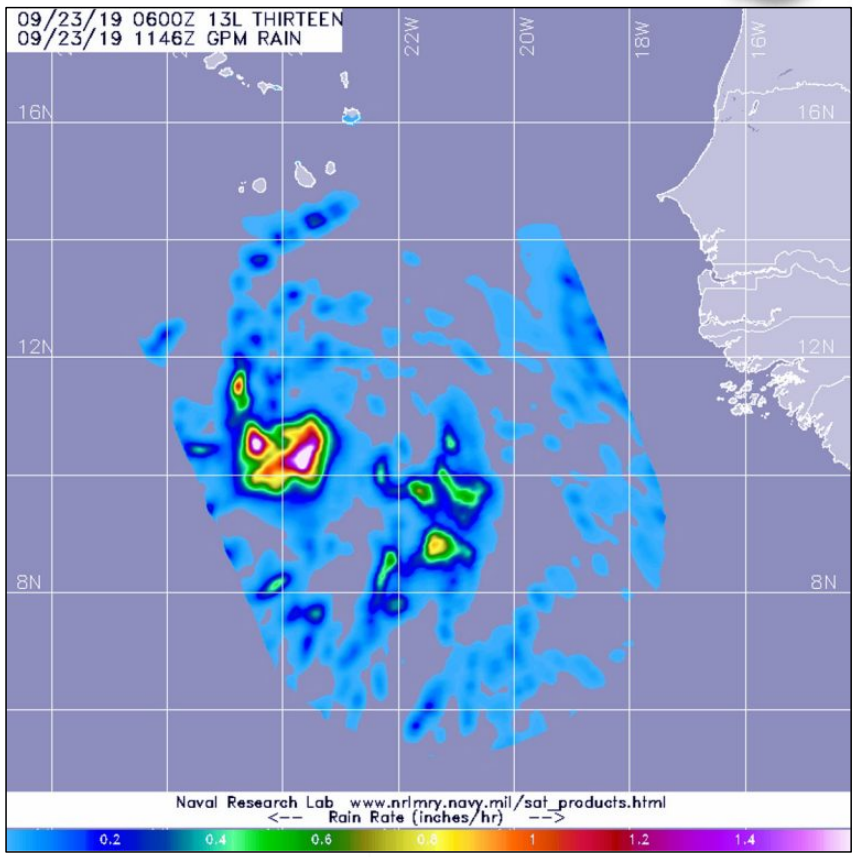
GLOBAL PRECIPITATION MEASUREMENT

Issue	Monitoring and forecasting storms to support disaster preparation and response
Objective	Use satellite imagery to monitor and track behavior of tropical cyclones
Solution	GMI data used by the NRL and NOAA's NHC to help understand behavior and location of Lorenzo
Results/ Benefit	GMI used by NHC to help communicate about the storm's behavior (and available to the public)

Recent GMI microwave imagery and ASCAT-C data showed that the low-level center of Lorenzo is on the north side of most of its deep convection. While this disorganized structure may limit how quickly Lorenzo can strengthen in the short-term, the tropical storm is located within a generally favorable environment for intensification. All of the intensity guidance shows Lorenzo becoming a hurricane, but the timing varies from model to model. The official forecast follows the HFIP Corrected Consensus, and shows Lorenzo reaching hurricane status within 48 h. Continued strengthening is forecast thereafter. No noteworthy changes were made to the NHC intensity forecast.

The ASCAT and microwave data were very helpful in determining the location of Lorenzo's center and its forward speed. The cyclone has accelerated and the initial motion estimate is now 275/15 kt. Very little adjustment was made to the NHC track forecast. Lorenzo is still forecast to be steered generally westward to west-northwestward to the south of a deep-layer ridge centered over the eastern Atlantic. The cyclone will pass well south and southwest of the Cabo Verde Islands through tonight. A turn toward the northwest is forecast in about 4 days as Lorenzo reaches a break in the ridge. Just like the intensity forecast, the track forecast is

The NHC provides regular updates of a storm's track, location, and behavior to the public. The NHC mentioned the use of the GMI instrument in a recent discussion of tropical storm Lorenzo on 09/23/2013 at 11am (above). Credit: https://www.nhc.noaa.gov/archive/2019/al13/al132019.discus.003.shtml



GPM's GMI provides a view of Lorenzo's precipitation, showing the heaviest rainfall near the center on 09/23/2019. Credit: NASA/JAXA/NRL

Addressing Drought on the Navajo Nation

Issue	**Monitoring and forecasting drought**
Objective	**Develop tool (DSET) for improved drought reporting**
Solution	**DSET connects NASA Earth Observations, modeled climate data, and in-situ rain gauge data for on-the-fly analyses**
Results/ Benefit	**DSET end products (field scale maps, time series figures, and reporting metrics) will assist in drought emergency declarations and the subsequent allocation of relief dollars across the NN**

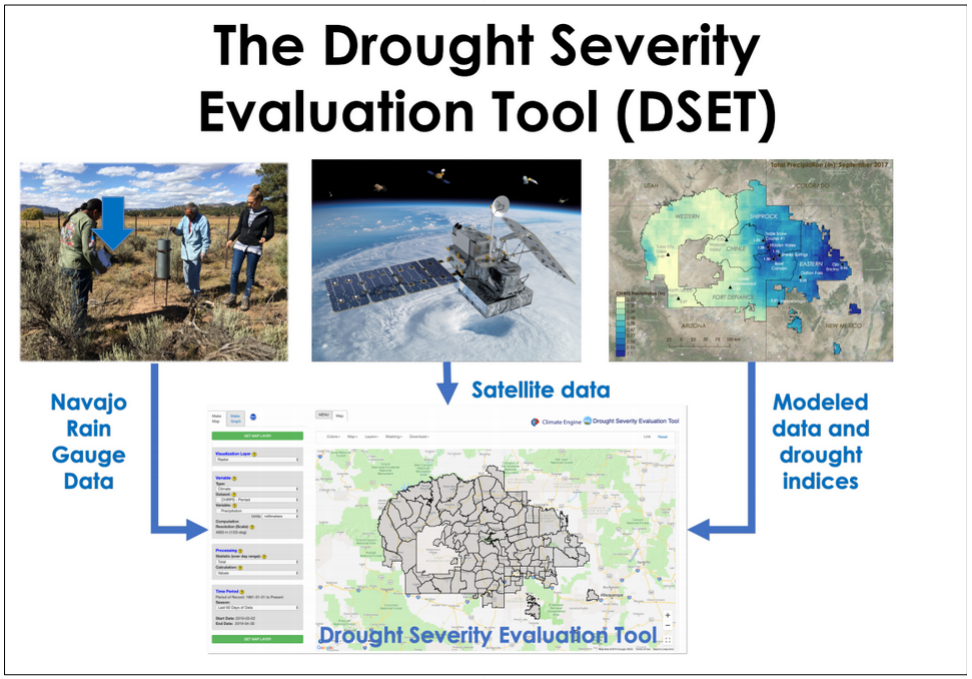
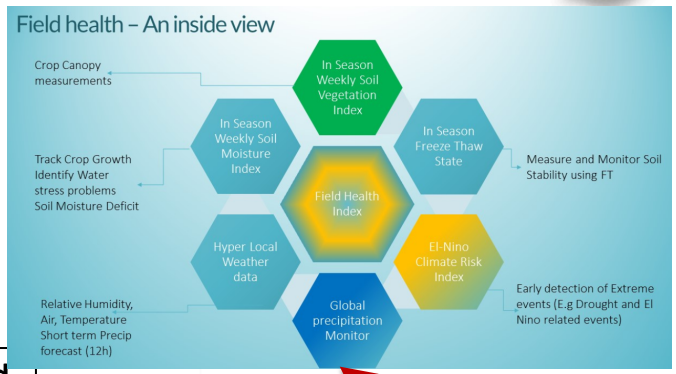


Image credit: Amber Jean McCullum[1], Justin Huntington[2], Britta Daudert[2], Carlee McClellan[3]
([1]Bay Area Environmental Research Institute/NASA Ames Research Center, [2]Desert Research Institute,[3]Navajo Nation Dept of Water Resources).

Monitoring and Managing Weather Risks with GPM

GLOBAL PRECIPITATION MEASUREMENT

Issue	**Protect farmers from financial disaster and combat food insecurity faced by environmental extremes**
Objective	**Work with companies to develop insurance platform that protects agricultural assets when a disaster strikes**
Solution	**Uses climate and weather data to monitor and manage risks in agriculture**
Results/ Benefit	**Work with thousands of farmers and companies throughout world to design payouts**



GPM

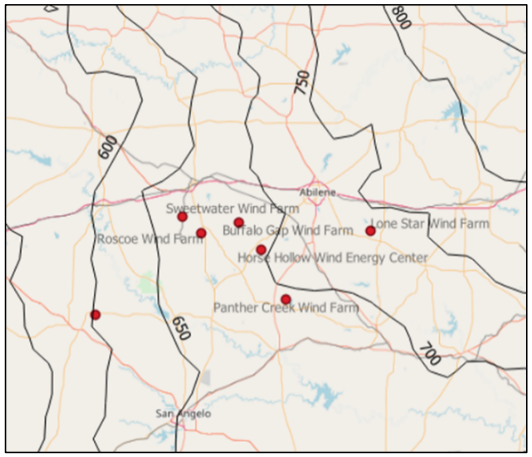
In April 2016, Argentina and Uruguay received upwards of 300mm above monthly average which led to flooding. To help assess the total crop damage and potential crop yield, Agvesto worked with the Argentine government to provide field health and risk insights using GPM precipitation and SMAP soil moisture data. Credit: Agvesto.

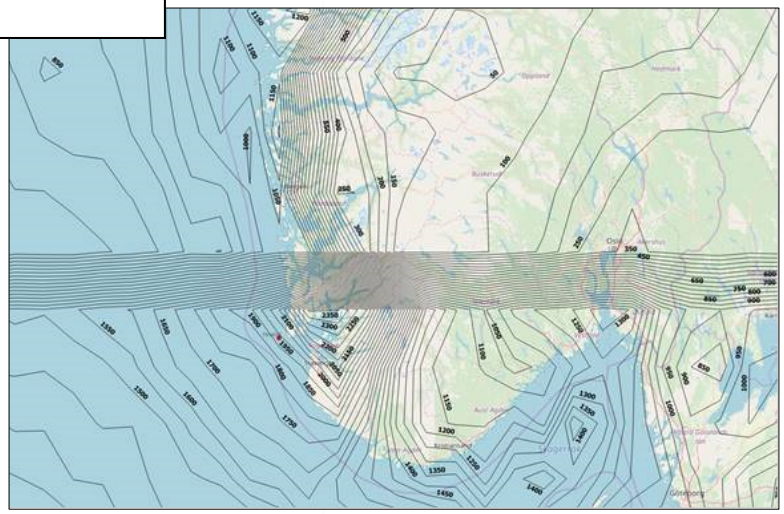
Evaluating Wind Turbine Longevity

GLOBAL PRECIPITATION MEASUREMENT

Issue	**Maximize blade reliability to effectively convert wind into energy**
Objective	**Understand how weather impacts wind turbine blades throughout the world**
Solution	**Provide information using GPM IMERG data to develop contour precipitation maps and determine average precipitation at existing and potential wind turbine site locations**
Results/ Benefit	**Work with customers and guarantee that wind turbine will last 20+ years within location**

LM WIND POWER





Map of average precipitation in Texas (left) and the North Sea and western Norway (right) depicted by black contour lines using GPM IMERG data.

Image credits: Laurids Andersen

Weather and Air Quality Forecasting Applications Workshop

- July 22-23, 2019, 40 experts (NASA, NOAA, NRL, JMA, JAXA, ECMWF, ECCC)
- Discuss how existing NASA satellite products could be better leveraged for NWP and AQ forecasting efforts and outline future needs for NASA's next generation satellite estimates
- Discuss utility and opportunities for future measurements for ACCP

Weather and AQ Workshop

Objectives:

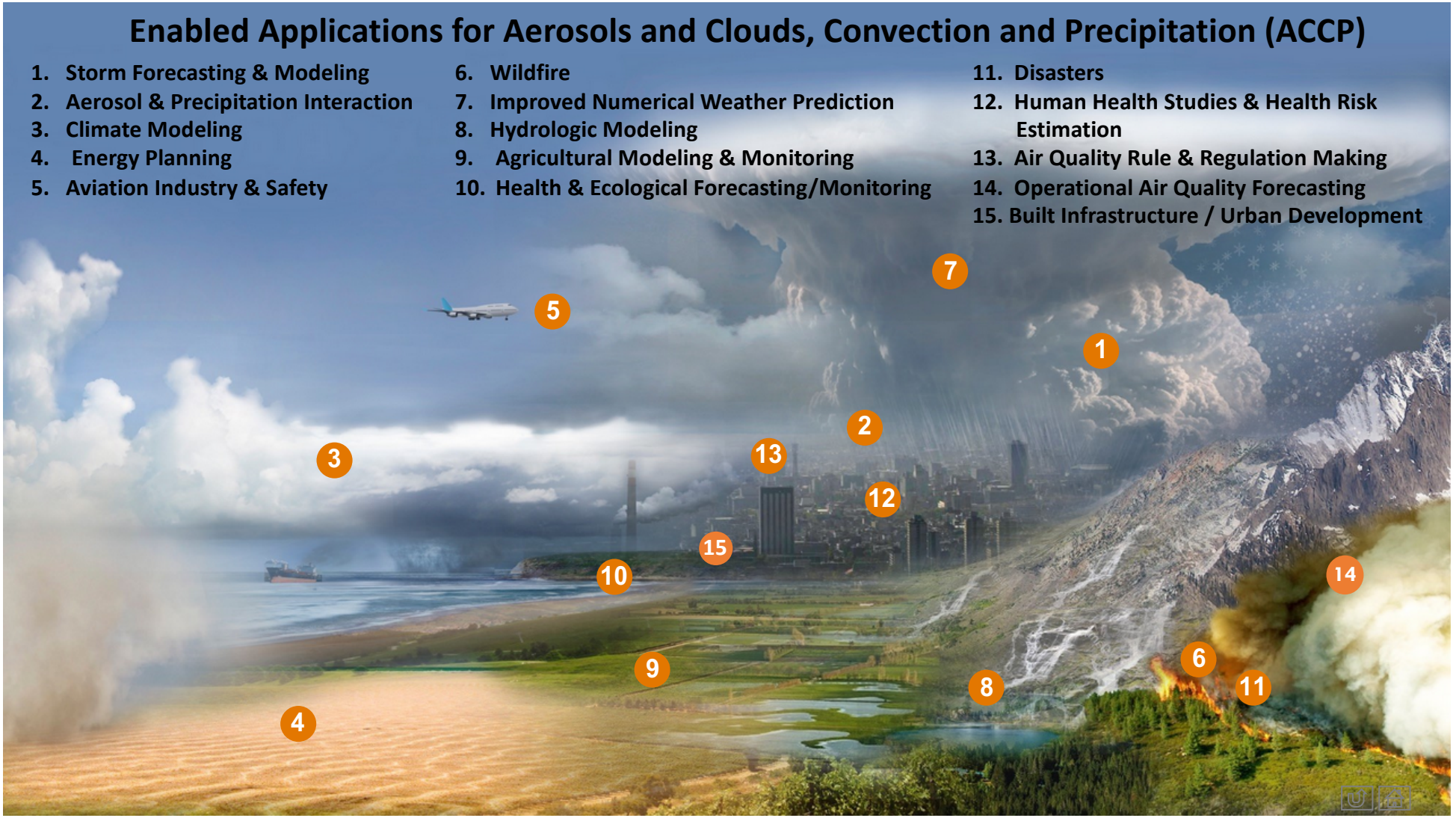
- Understand how GPM data products are currently assimilated in NWP modeling and opportunities for future applications;
- Explore barriers and solutions related to the assimilation of satellite observations into NWP models and opportunities for AQ forecasting;
- Assess how future measurements from the ACCP concept study may be utilized by the NWP and AQ forecast community; and
- Increase awareness of the needs of the NWP and AQ forecast community for future research developments and collaboration.

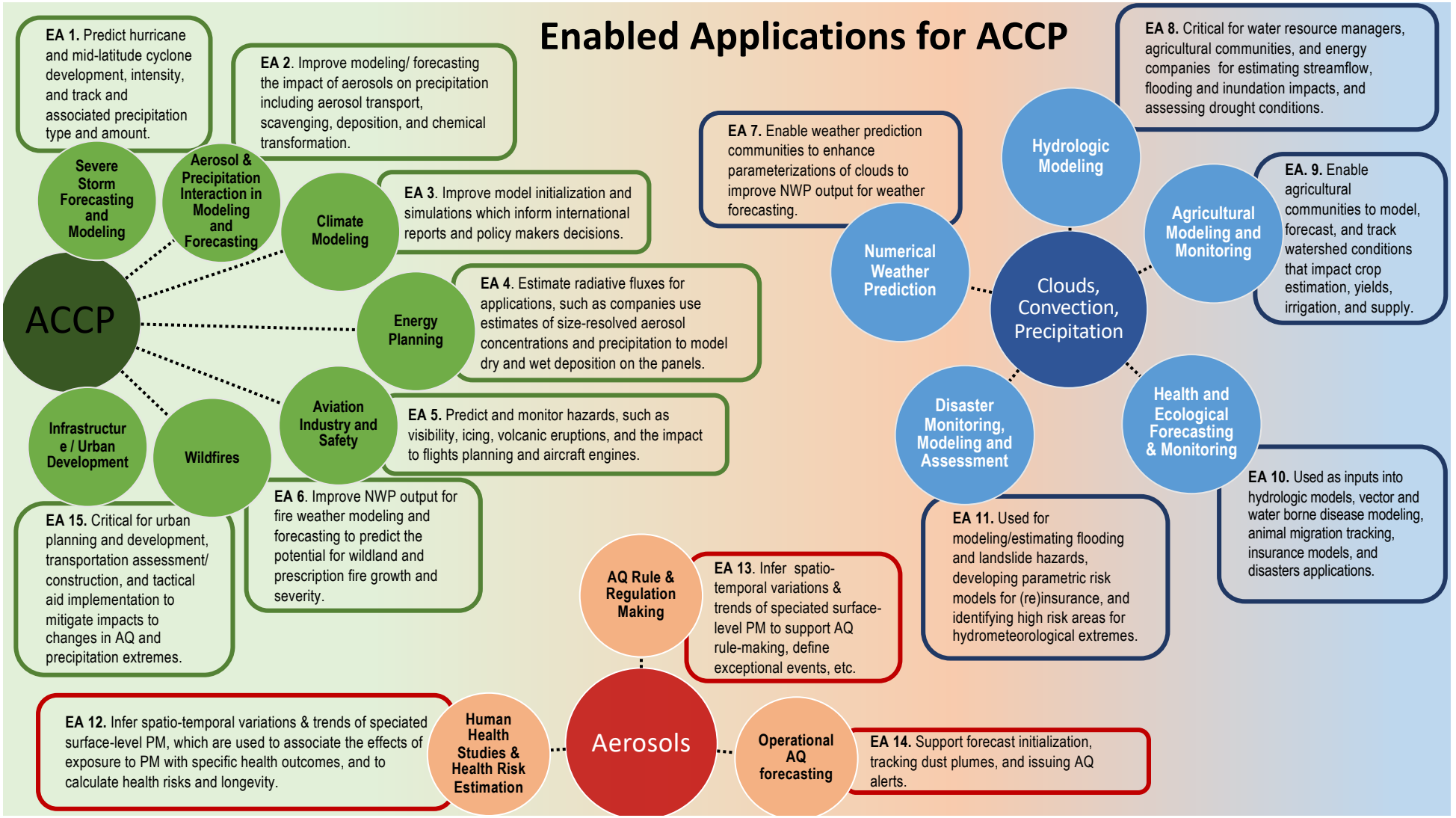
End Products:

1) Series of highlights
2) White paper
3) Workshop summary for EOS
4) Direct input to inform A-CCP's SATM and Applications Library documents

Enabled Applications for Aerosols and Clouds, Convection and Precipitation (ACCP)

1. Storm Forecasting & Modeling
2. Aerosol & Precipitation Interaction
3. Climate Modeling
4. Energy Planning
5. Aviation Industry & Safety
6. Wildfire
7. Improved Numerical Weather Prediction
8. Hydrologic Modeling
9. Agricultural Modeling & Monitoring
10. Health & Ecological Forecasting/Monitoring
11. Disasters
12. Human Health Studies & Health Risk Estimation
13. Air Quality Rule & Regulation Making
14. Operational Air Quality Forecasting
15. Built Infrastructure / Urban Development

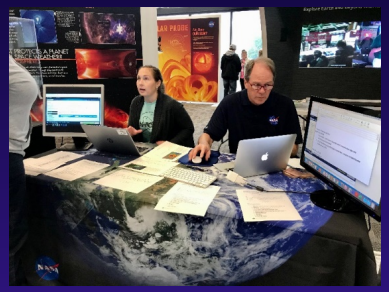



Enabled Applications for ACCP
EA 1. Predict hurricane and mid-latitude cyclone development, intensity, and track and associated precipitation type and amount.
EA 2. Improve modeling/ forecasting the impact of aerosols on precipitation including aerosol transport, scavenging, deposition, and chemical transformation.
EA 8. Critical for water resource managers, agricultural communities, and energy companies for estimating streamflow, flooding and inundation impacts, and assessing drought conditions.
EA 7. Enable weather prediction communities to enhance parameterizations of clouds to improve NWP output for weather forecasting.
Severe Storm Forecasting and Modeling
Aerosol & Precipitation Interaction in Modeling and Forecasting
Climate Modeling
EA 3. Improve model initialization and simulations which inform international reports and policy makers decisions.
Hydrologic Modeling
Agricultural Modeling and Monitoring
EA. 9. Enable agricultural communities to model, forecast, and track watershed conditions that impact crop estimation, yields, irrigation, and supply.
ACCP
Energy Planning
EA 4. Estimate radiative fluxes for applications, such as companies use estimates of size-resolved aerosol concentrations and precipitation to model dry and wet deposition on the panels.
Numerical Weather Prediction
Clouds, Convection, Precipitation
Infrastructure / Urban Development
Wildfires
Aviation Industry and Safety
EA 5. Predict and monitor hazards, such as visibility, icing, volcanic eruptions, and the impact to flights planning and aircraft engines.
Disaster Monitoring, Modeling and Assessment
Health and Ecological Forecasting & Monitoring
EA 10. Used as inputs into hydrologic models, vector and water borne disease modeling, animal migration tracking, insurance models, and disasters applications.
EA 6. Improve NWP output for fire weather modeling and forecasting to predict the potential for wildland and prescription fire growth and severity.
EA 11. Used for modeling/estimating flooding and landslide hazards, developing parametric risk models for (re)insurance, and identifying high risk areas for hydrometeorological extremes.
EA 15. Critical for urban planning and development, transportation assessment/ construction, and tactical aid implementation to mitigate impacts to changes in AQ and precipitation extremes.
AQ Rule & Regulation Making
EA 13. Infer spatio-temporal variations & trends of speciated surface-level PM to support AQ rule-making, define exceptional events, etc.
EA 12. Infer spatio-temporal variations & trends of speciated surface-level PM, which are used to associate the effects of exposure to PM with specific health outcomes, and to calculate health risks and longevity.
Human Health Studies & Health Risk Estimation
Aerosols
Operational AQ forecasting
EA 14. Support forecast initialization, tracking dust plumes, and issuing AQ alerts.

GPM Outreach Activities

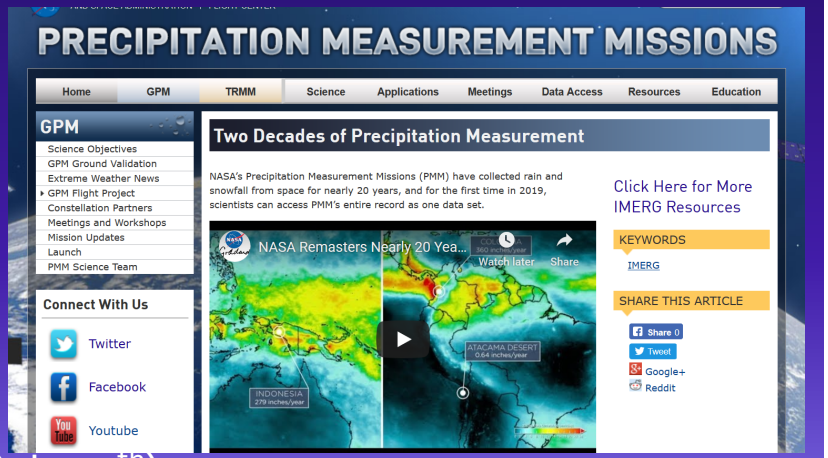
2019 Fall IMERG Campaign

Oct 15 -20, 2019: GPM launched campaign to highlight release of V06 IMERG!

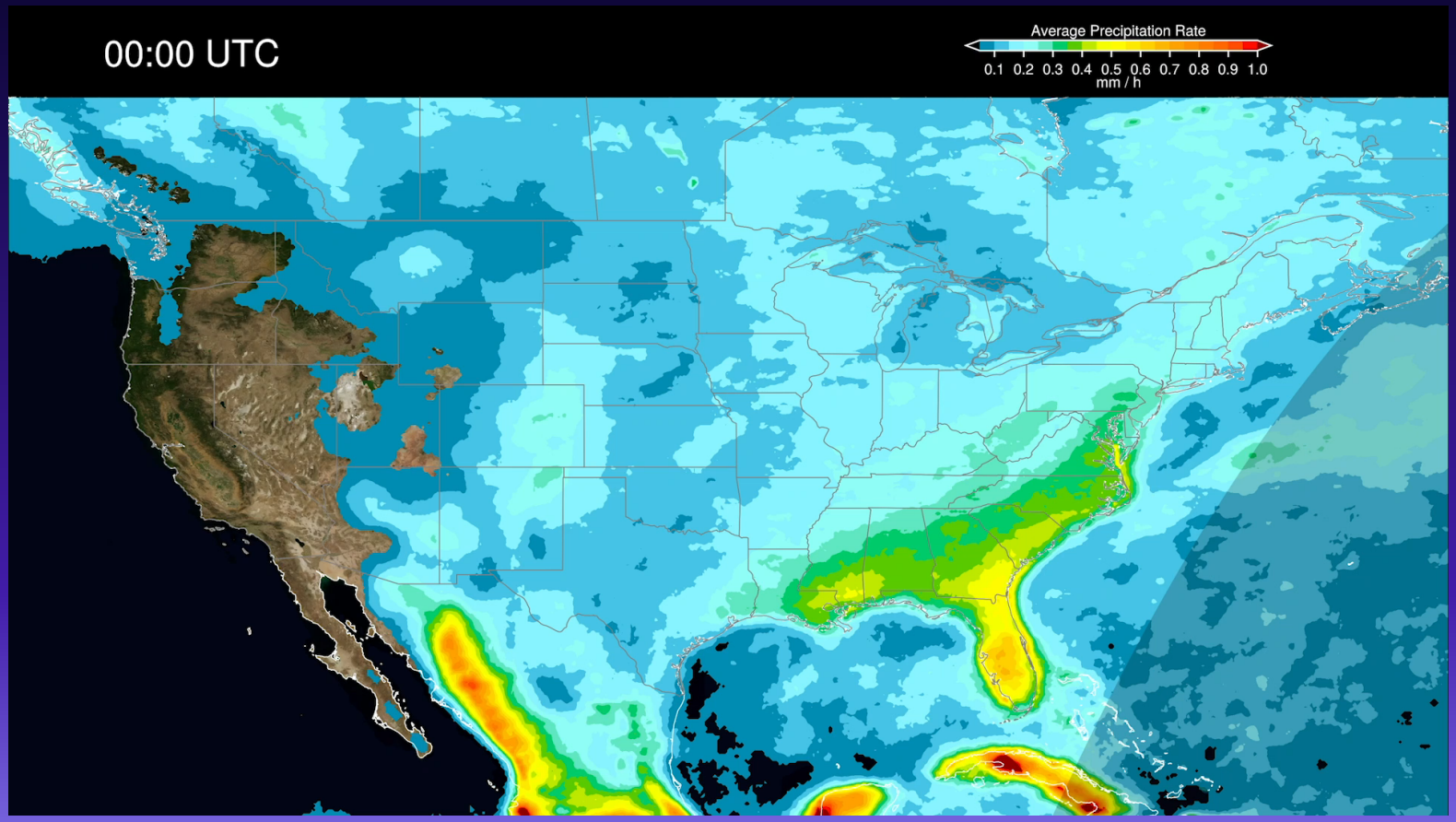


Campaign events included:

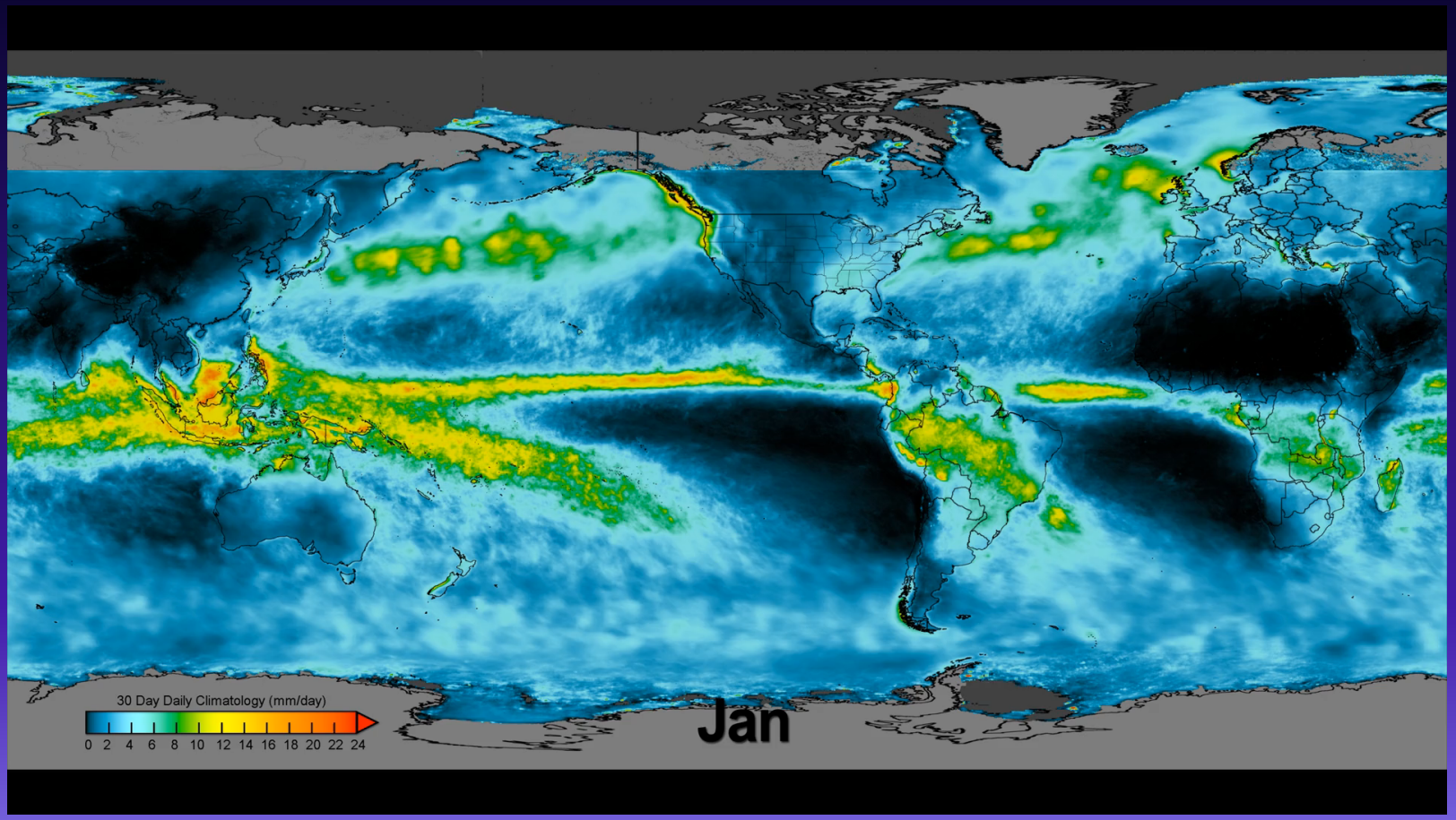
- NASA.gov feature
- Six core data visualization products
- NASA Live Shots morning that consisted of 31 TV, radio, and print interviews
- Introductory applications webinar (>110 registrants)
- NASA GSFC Visitors Center Sunday Experiment
- PMM Webpage to support activities
- Social Media posts (Tumblr, Snapchat story posted Oct. 29th)

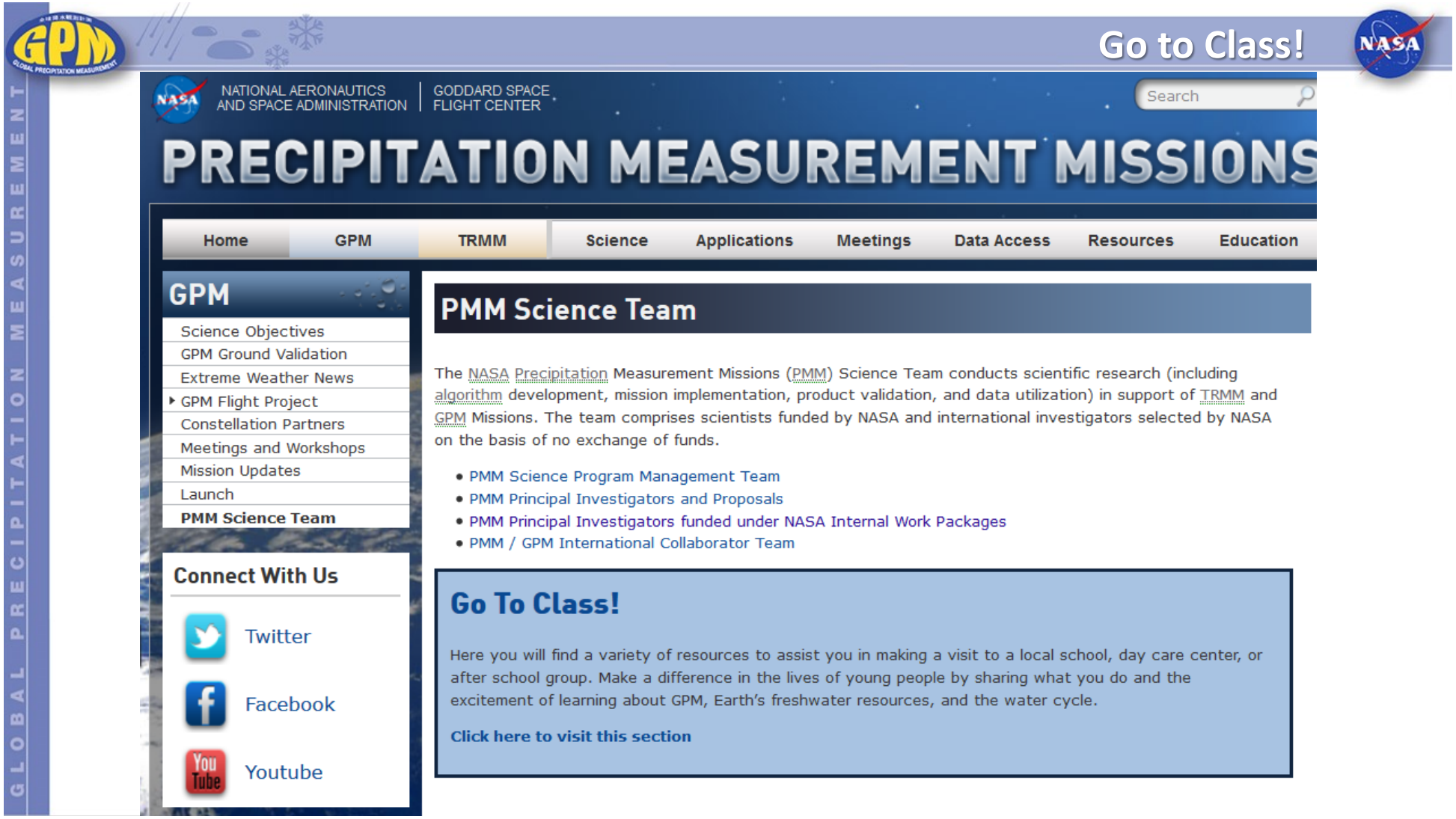


Precipitation Diurnal Cycles



IMERG Daily Climatology




Go to Class!
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Extreme Weather News
GPM Flight Project
Constellation Partners
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Mission Updates
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PMM Science Team
The NASA Precipitation Measurement Missions (PMM) Science Team conducts scientific research (including algorithm development, mission implementation, product validation, and data utilization) in support of TRMM and GPM Missions. The team comprises scientists funded by NASA and international investigators selected by NASA on the basis of no exchange of funds.
PMM Science Program Management Team
PMM Principal Investigators and Proposals
PMM Principal Investigators funded under NASA Internal Work Packages
PMM / GPM International Collaborator Team
Go To Class!
Here you will find a variety of resources to assist you in making a visit to a local school, day care center, or after school group. Make a difference in the lives of young people by sharing what you do and the excitement of learning about GPM, Earth's freshwater resources, and the water cycle.
Click here to visit this section

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION | GODDARD SPACE FLIGHT CENTER

PRECIPITATION MEASUREMENT

Home | GPM | TRMM | Science | Applications | Meetings | Data Acc

Resources

- Images
  - PMM
  - GPM
  - TRMM
  - Flight Project
  - Ground Validation
- Videos
  - GPM
  - TRMM
  - Ground Validation
- Featured Articles Archive
- Media & Press
- GPM Refereed Publications
- TRMM Refereed Publications
- Documents
- Related Sites
- Glossary
- Acronyms
- 3D Printed GPM Preciptation Data
- **Go To Class**
  - Early Childhood
  - Elementary
  - High School
  - Middle School
  - Preschool

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Youtube

Need Help?

- View Frequently Asked Questions
- View the PMM Glossary
- Contact Us

Go To Class

We Want You to Go to Class!

Our students desperately need to have some face to face time with scientists and engineers who are doing amazing things to make their world a better place. That means you guys! From time to time, you may be invited to give a presentation on your work to kids in some context- and we want to make it easier for you. You might even reach out yourself to your local school and offer to come in and give a talk.

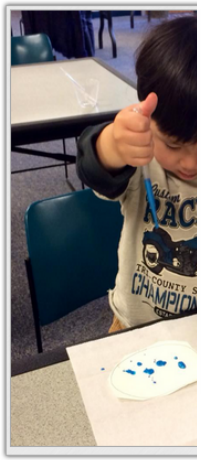
Having been a classroom teacher across all grade levels by the time I finished my illustrious career, I know personally the joy of having real STEM professionals come in and share the excitement and wonder of their work with my students. I also know that many of them felt a bit out of their comfort zone trying to explain what they did to the eager little 6-year-old faces looking up at them. Below you will find some hints, Best Practices, links to the National Science Standards, and sample activities to do with kids across all grade levels, from pre-K to high school!

Should you have any questions, feel free to reach out to me. I can also send you some GPM "droplets", anime comic books, and/or stickers to hand out while you are visiting the students. Contact me at dorian.w.janney@nasa.gov . Be sure to give me at least three weeks to mail things out.

Click on the age/grade levels below to see ideas for how you can "Go to Class" and make lasting memories as you inspire kids and their teachers!

- Preschool (ages 2 through 5 years)
- Early Childhood (grades K through 2nd)
- Elementary School (grades 3rd-5th)
- Middle School (grades 6-8)
- High School (grades 9-12)

Preschool



These are such fun little people lots of enthusiasm and questio everything they know and then turn to share in. While that is e you are trying to convey pretty

Here are some general guidelines

- **A typical presentation to t like this:**
  - Everyone is sitting on t sitting on a small chair on carpet squares or in
  - You introduce yourself, you if they know you a introduction your name hydrologist; and what
  - A very short introductio about clouds and how t a little bit about how ra When I am finished, w learn a little more".
  - You talk for a few minu everyone can respond out the answer togethe about their weekend a sidetracked if you allov questions by individual
  - Have a few slides to sh I will list a few suggest age level. When you sl the slide pointing thing call out the names of t have them repeat som the water cycle (only th evaporation- condensa

Early Childhood

Students in K-2nd grades are eage scientist come to visit their class often like to share their experienc look over the suggestions in the Best Practices for giving presentat

There are many ways in which the meaningful and engaging to child some of the Next Generation Scie states across the country) that rel might present on to children in th attempting to teach everything in information in the standard will gi children in that grade level need t their knowledge. You are just one achieve these rather broad and co

Kindergarten:

- K-ESS2 Earth's Systems
- K-ESS3 Earth and Human Acti

First Grade:

- 1-LS1 From Molecules to Orga

Second Grade:

- 2-ESS2-1 Earth's Systems
- 2- LS2 Ecosystems: Interactio

The key topic areas that are relev these grade levels center around availability/resources. You can fin videos we have developed and ga topics below. You might look over could also forward the lists to the resources.

High School

Students in high school are very interested in hearing about science from "real" scientists! Although they have a lot of background knowledge about natural phenomena, they will also have misconceptions as well. They are also at the age in which they will begin to consider their future career interests, and hearing from you about why you chose your career will be very interesting to them. They may be reticent at first to answer questions for fear of "sticking out" among their peers. Take a few minutes to read over the "Giving Presentations in Secondary Schools" get a feel for what secondary school classes are like and some pointers for presenting to students in these grade levels.

There are many ways in which the science behind the GPM mission is meaningful and engaging to students in high school classes. Here are some of the Next Generation Science Standards (followed by most states across the country) that relate directly themes germane to GPM's science and technology. Note that you aren't attempting to teach everything in the standards below- rather the information in the standard will give you a sense of what ultimately children in that grade level need to know and do to demonstrate their knowledge. You are just one small step toward helping them achieve these rather broad and complicated standards of science.

- HS- ESS2 Earth's Systems
- HS- ESS3 Earth and Human Activity
- HS- PS4 Waves and their Applications in Technologies for Information Transfer
- HS- ETS1 Engineering Design

The key topic areas that are relevant to GPM and are related to students in these grade levels center around the water cycle and freshwater availability/resources. You can find many of the lessons plans and videos we have developed and gathered related to each of these topics below. You might look over these to get some ideas, and could also forward the lists to the teacher to offer them additional resources.

SHARE THIS ARTICLE

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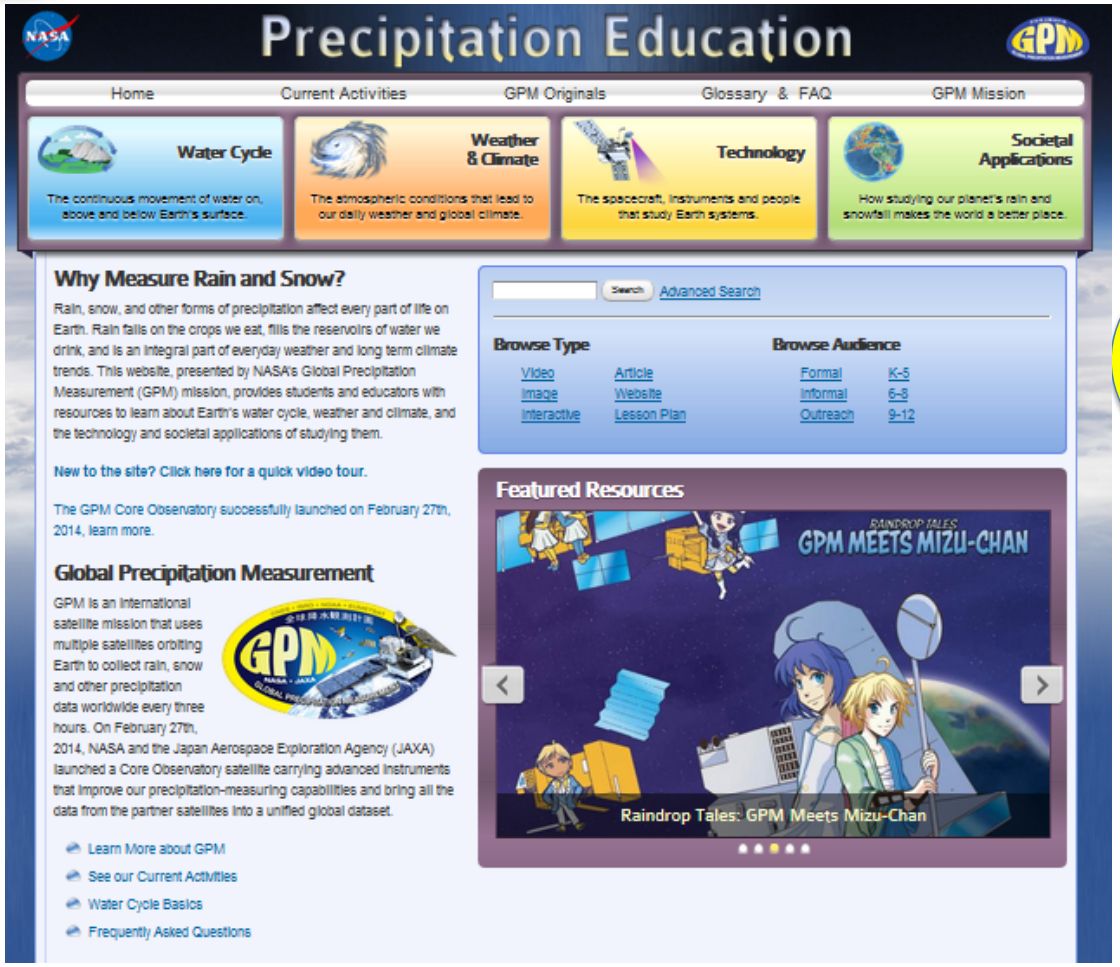
Go to a Grade

- Preschool
- Early Childhood
- Elementary School
- Middle School
- High School

Precipitation Education Webpage



https://pmm.nasa.gov/education/

302,836 pageviews in month of October (new all-time high!)

PMM Website: 95,000 pageviews per month

GPM Social Media Accounts

GLOBAL PRECIPITATION MEASUREMENT

Twitter: NASARain

27,000+ followers

https://www.twitter.com/NASA_Rain

Facebook: NASARain

52,500+ Followers

https://www.facebook.com/NASA.Rain

https://pmm.nasa.gov/

New website coming soon!

https://pmm.nasa.gov/applications

New website will include

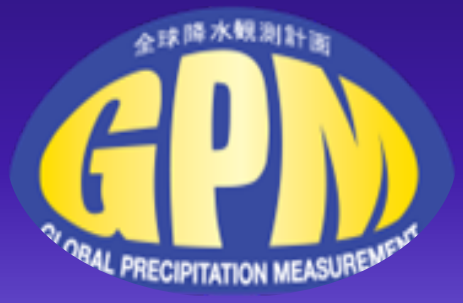
- Application Highlights
- Application resources (one-pagers)
- Application Videos/ visualizations

Next Steps……

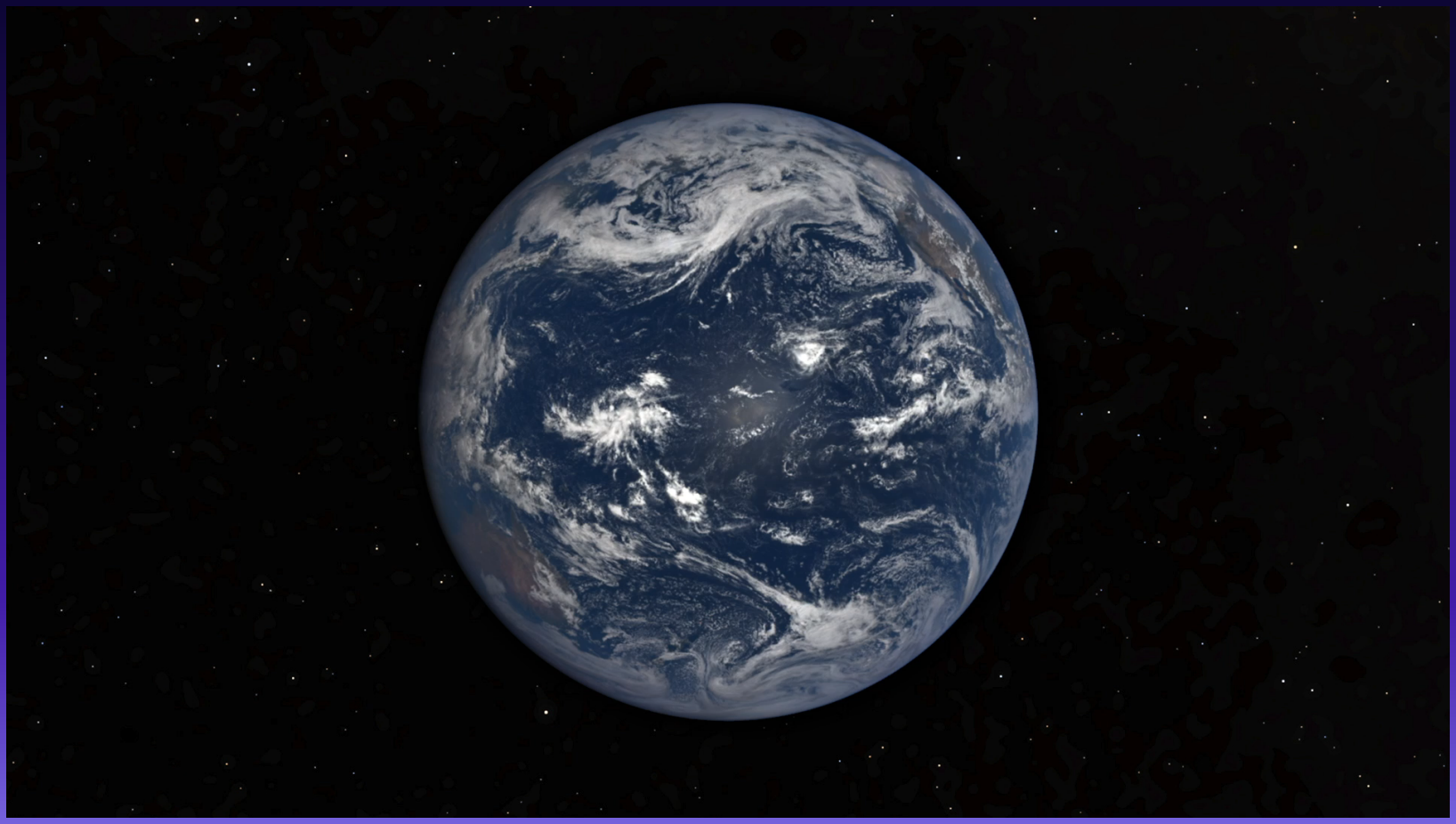
Share your application or data use story!

Contribute to the ACCP applications community

Come to the working group meeting (Wednesday @ lunch)

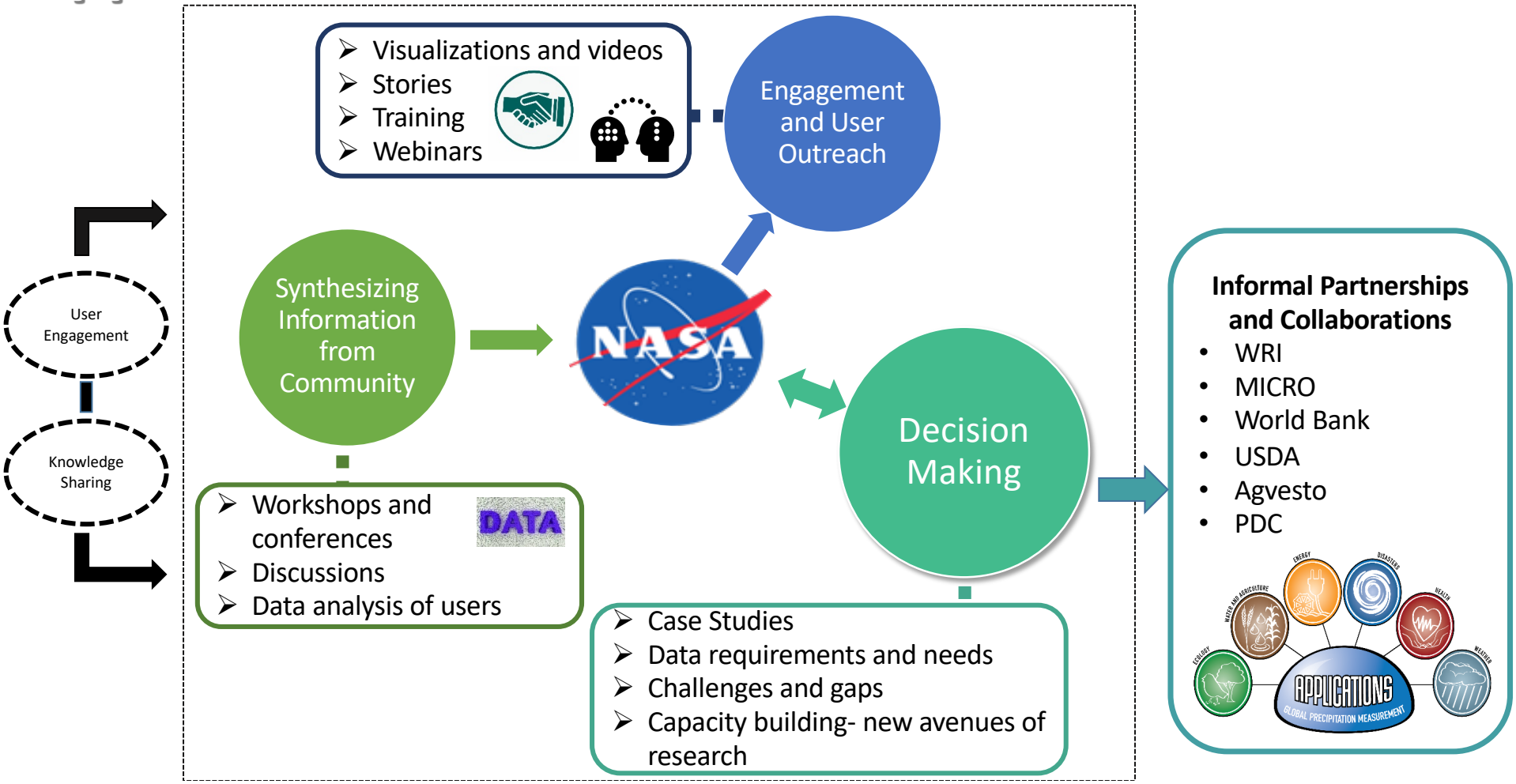


IMERG Daily Cycle of Rain



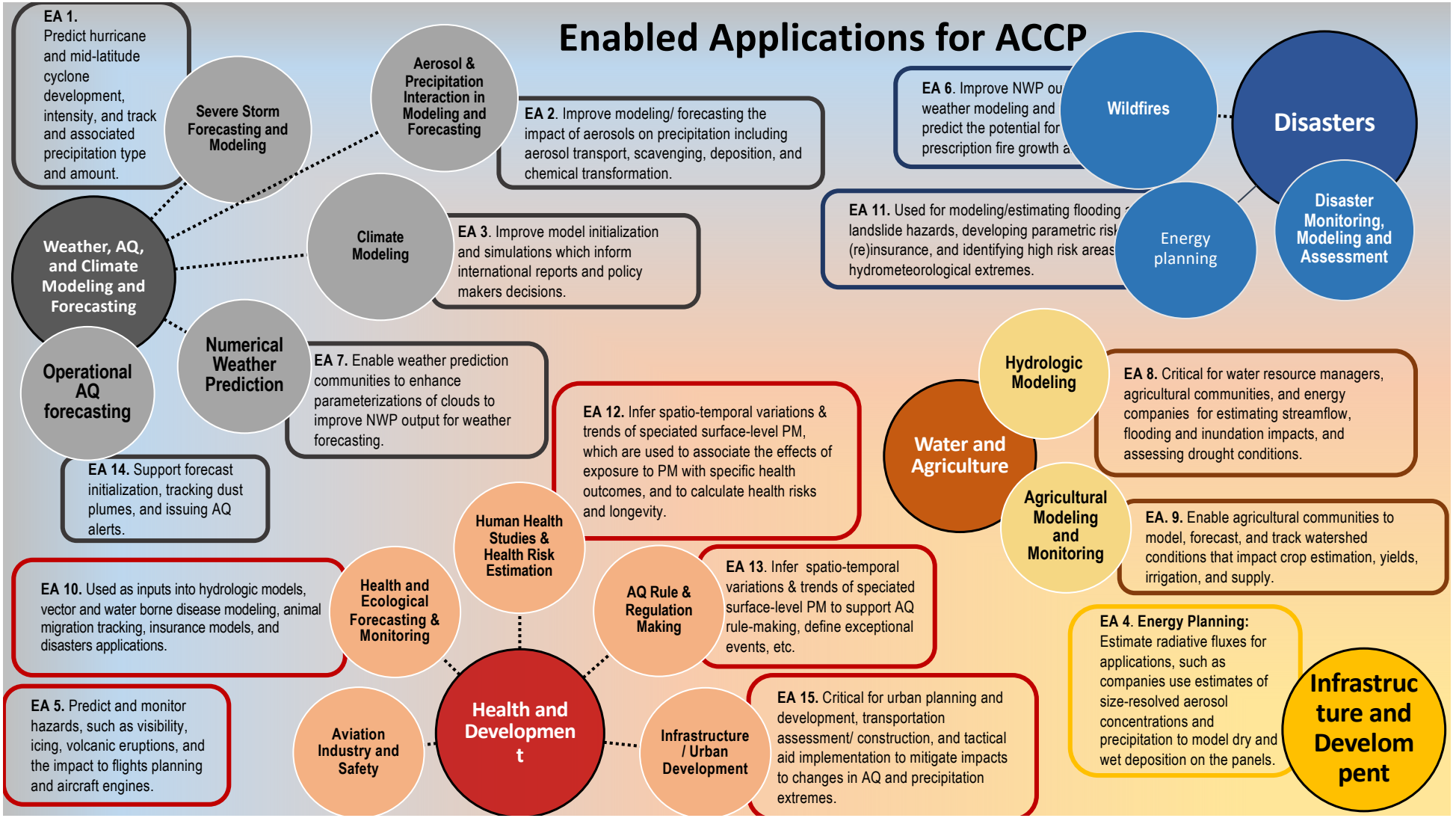
Extra Slides

Applications: How it works

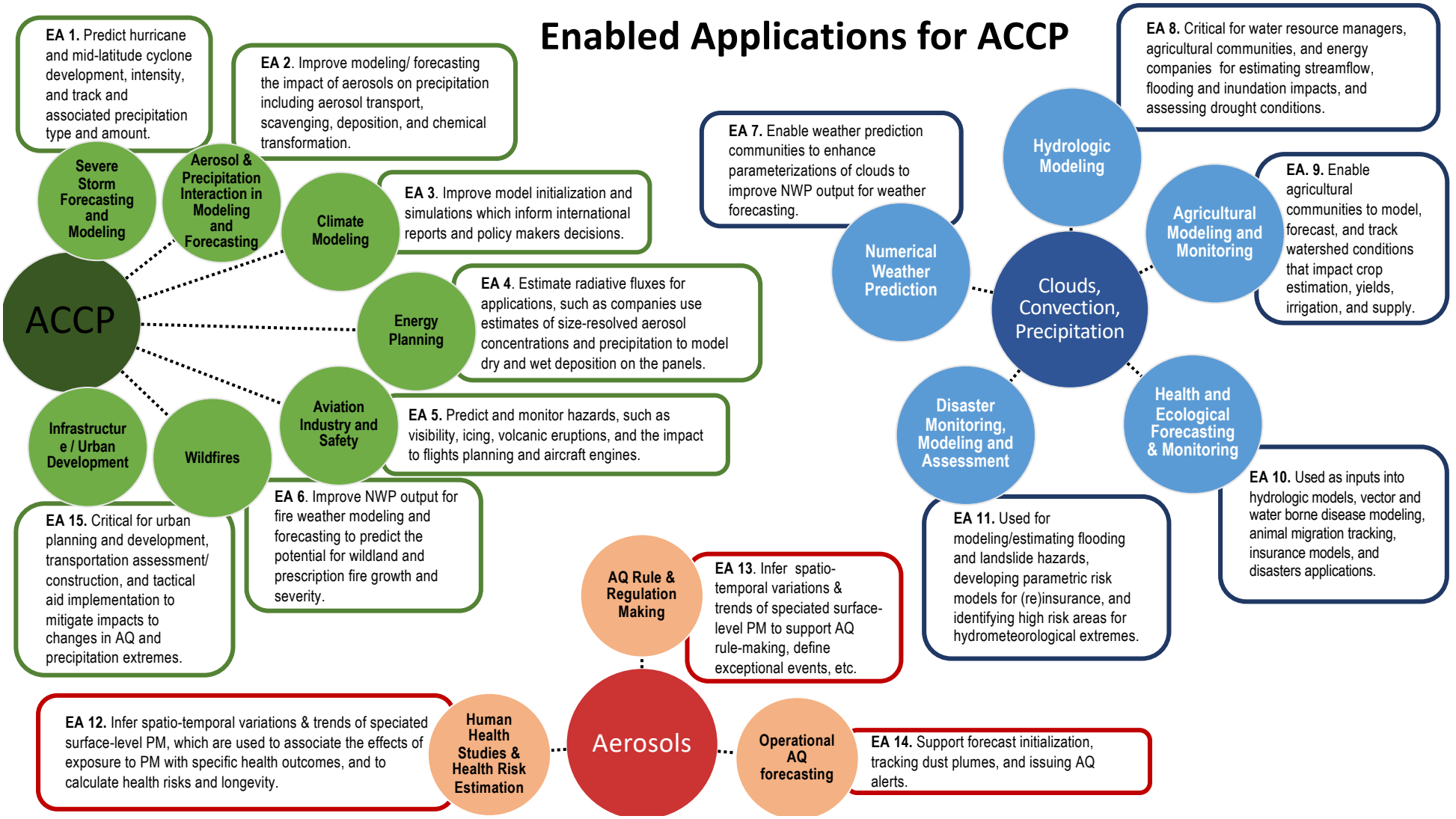


GPM Applications Overview and Objectives

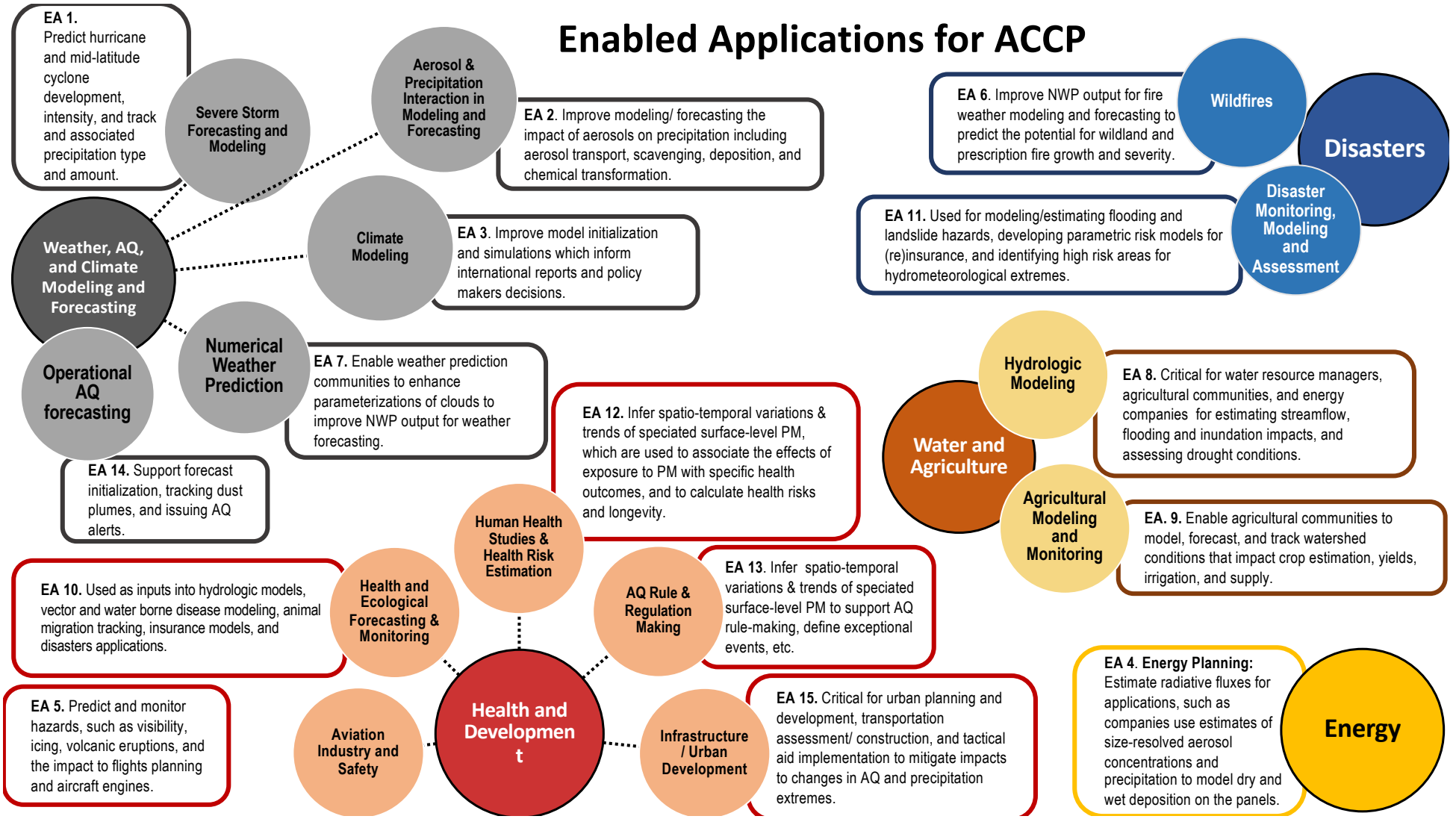
1. **Increase awareness** of GPM and TRMM applications focusing on both broad areas and targeted thematically-focused communities
   - One pagers and videos outlining GPM applications examples: floods, public health, agriculture, and tropical cyclone forecasting
   - Extensive outreach effort and demonstration of how end users are working with the data
2. **Engage users communities** in trainings, workshops, and case studies to improve awareness and use of data and gain feedback in how the data products are used for decision making
   - Webinar training sessions (2018-19) introducing GPM data
   - Stakeholder workshops (Weather and AQ)
3. **Improve data access** and visualization of core GPM products for rapid ingestion and analysis
   - Visualization and data access capabilities for all levels of experience
   - Updated Data Access Portal: https://pmm.nasa.gov/data-access


Enabled Applications for ACCP
EA 1. Predict hurricane and mid-latitude cyclone development, intensity, and track and associated precipitation type and amount.
Severe Storm Forecasting and Modeling
Aerosol & Precipitation Interaction in Modeling and Forecasting
EA 2. Improve modeling/ forecasting the impact of aerosols on precipitation including aerosol transport, scavenging, deposition, and chemical transformation.
EA 6. Improve NWP ou
weather modeling and
predict the potential for
prescription fire growth a
Wildfires
Disasters
Weather, AQ, and Climate Modeling and Forecasting
Climate Modeling
EA 3. Improve model initialization and simulations which inform international reports and policy makers decisions.
EA 11. Used for modeling/estimating flooding
landslide hazards, developing parametric risk
(re)insurance, and identifying high risk areas
hydrometeorological extremes.
Energy planning
Disaster Monitoring, Modeling and Assessment
Operational AQ forecasting
Numerical Weather Prediction
EA 7. Enable weather prediction communities to enhance parameterizations of clouds to improve NWP output for weather forecasting.
Hydrologic Modeling
EA 8. Critical for water resource managers, agricultural communities, and energy companies for estimating streamflow, flooding and inundation impacts, and assessing drought conditions.
EA 12. Infer spatio-temporal variations & trends of speciated surface-level PM, which are used to associate the effects of exposure to PM with specific health outcomes, and to calculate health risks and longevity.
Water and Agriculture
Agricultural Modeling and Monitoring
EA. 9. Enable agricultural communities to model, forecast, and track watershed conditions that impact crop estimation, yields, irrigation, and supply.
EA 14. Support forecast initialization, tracking dust plumes, and issuing AQ alerts.
Human Health Studies & Health Risk Estimation
EA 10. Used as inputs into hydrologic models, vector and water borne disease modeling, animal migration tracking, insurance models, and disasters applications.
Health and Ecological Forecasting & Monitoring
AQ Rule & Regulation Making
EA 13. Infer spatio-temporal variations & trends of speciated surface-level PM to support AQ rule-making, define exceptional events, etc.
EA 4. Energy Planning: Estimate radiative fluxes for applications, such as companies use estimates of size-resolved aerosol concentrations and precipitation to model dry and wet deposition on the panels.
Infrastructure and Development
EA 5. Predict and monitor hazards, such as visibility, icing, volcanic eruptions, and the impact to flights planning and aircraft engines.
Aviation Industry and Safety
Health and Development
Infrastructure / Urban Development
EA 15. Critical for urban planning and development, transportation assessment/ construction, and tactical aid implementation to mitigate impacts to changes in AQ and precipitation extremes.

Enabled Applications for ACCP



Enabled Applications for ACCP



SPoRT's use of RGB Imagery for Hurricane Dorian

GLOBAL PRECIPITATION MEASUREMENT

Many factors can act together to contribute to storm intensification, and satellite imagery offers a variety of perspectives to monitor the evolution of tropical cyclone structure as a storm undergoes intensity change. Multispectral Red-Green-Blue (RGB) composite imagery derived from the GPM Constellation of passive microwave sensors provides value in monitoring the evolution of convection within a tropical cyclone, and can reveal structures such as developing and concentric eyewalls, as well as spiral rainbands. On August 28th and 29th, 2019, RGB imagery provided by the Short-term Prediction Research and Transition Center (SPoRT) captured Dorian's spiral rainband structure, as well as the presence of an eye before moving north towards the Bahamas. The NASA SPoRT center has a history of providing RGB imagery to national centers, including the National Hurricane Center (NHC) for use in operations. Today, the imagery is extensively used in hurricane analysis and forecasting, leveraging the ability to detect features of interest and to identify the hurricane center, structure, and intensity.

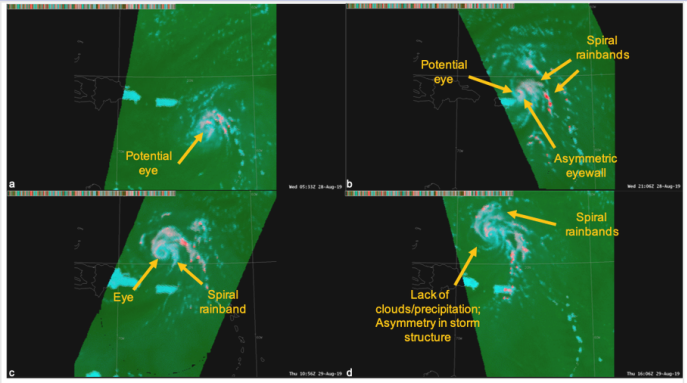


Figure 1: Evolution of Dorian from 08/28/19—08/29/19 as viewed from the 37 GHz RGB, which is sensitive to warm precipitation. Light blue colors demonstrate regions of lighter rain, indicative of mainly stratiform precipitation, and pink to red colors demonstrate areas of heavier rainfall, indicative of convective precipitation.

Check out full article at SPoRT

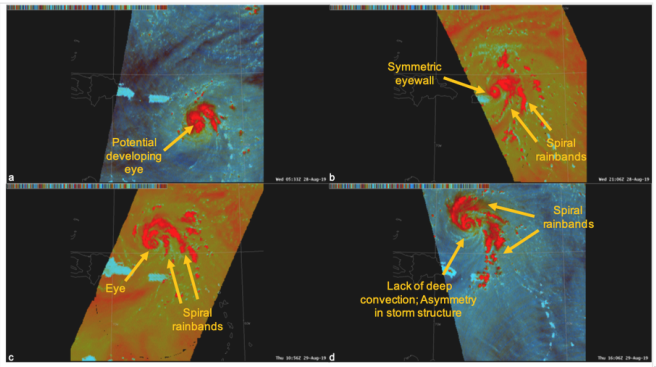


Figure 2: Same snapshots from Figure 1, but using the 89 GHZ RGB imagery, which is sensitive to frozen precipitation. Red colors indicate regions of strong convection.

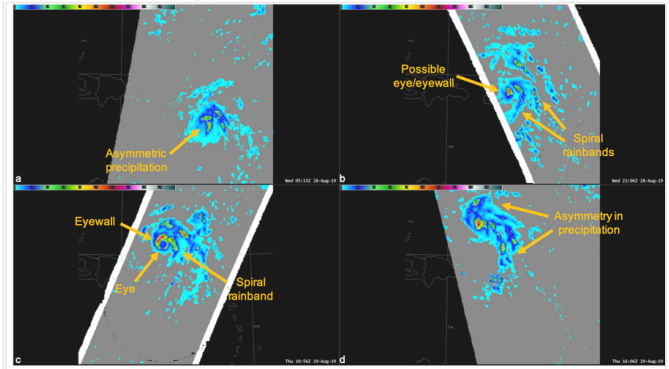
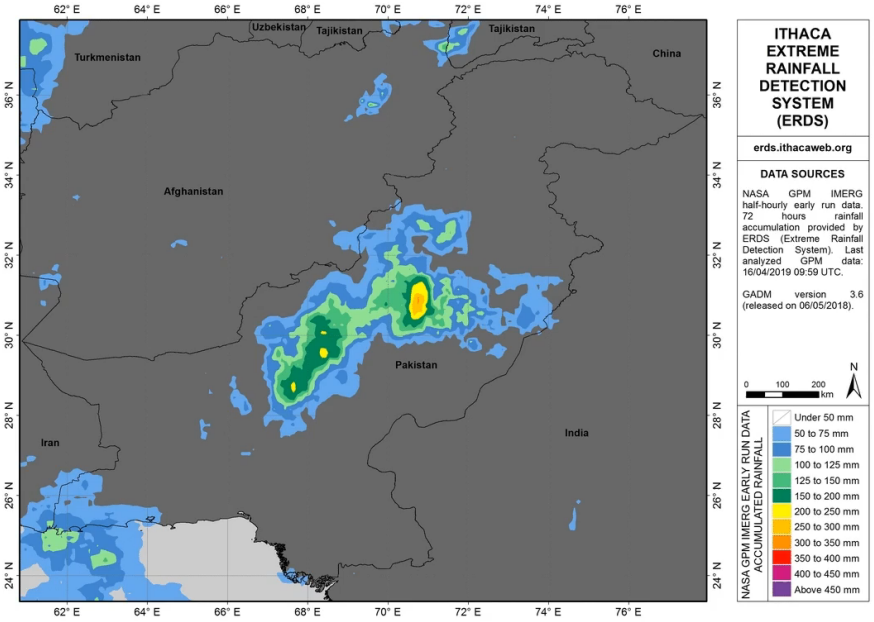


Figure 3: Satellite-derived instantaneous rain rate (in/hr) for the same snapshots of Figures 1-2. These images provide another perspective on storm structure by demonstrating where precipitation is occurring.

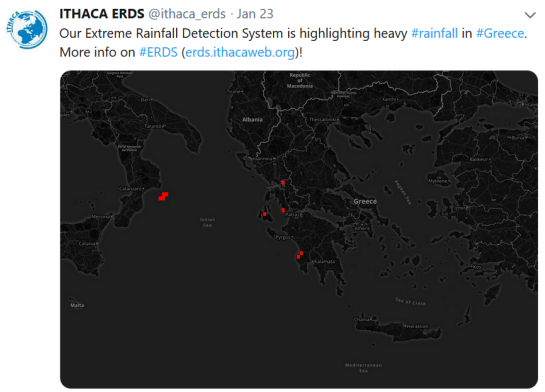
Caption and Image credit: Erika Duran, Emily Berndt, and Patrick Duran (NASA SPoRT), https://nasasport.wordpress.com/2019/08/30/the-evolution-of-hurricane-dorian-as-viewed-from-nasas-gpm-constellation/?linkId=72896134.

GPM Data Used to Provide Early Warning of Extreme Rainfall Events in Developing Countries

GPM IMERG data is used as an input within the Extreme Rainfall Detection System (ERDS) to provide immediate information about potential extreme hydrological events throughout the world.



ERDS visual communicating the severe rainfall over Pakistan in April 2019 using IMERG data. This was posted on the ERDS Twiiter account, @Ithaca_erds.



ERDS web application highlighting rainfall in Greece in January 2019. Credit: http://erds.ithacaweb.org/ via @Ithaca_erds.

- ERDS is a web GIS applications service for monitoring and forecasting extreme rainfall events- http://erds.ithacaweb.org/.
- ERDS is developed and implemented by the Information Technology for Humanitarian Assistance, Cooperation, and Action (ITHACA) - http://www.ithacaweb.org/ - and used by the UN World Food Programme (WFP) Emergency Preparedness Unit and multiple emergency management service organizations.
- ERDS Twitter account, @Ithaca_erds, has multiple examples how GPM IMERG data has been used for disaster response and preparation in over 20 countries!

Engage users communities

Engagement and User Outreach

1. Trainings
   - Webinar training sessions (2018-2019: Disease Initiative and IMERG V06 webinars
2. Workshops
   - Stakeholder workshops (Weather and Air Quality)
3. Informal PMM Applications Working Group
   - Provides guidance on new directions
4. Case studies: Weekly highlights
   - Improve awareness and traceability of data through the decision making pipeline and gain feedback in improving data and access pipelines

Next Steps……

- GPM Applications team will continue to engage the user community by thematic areas as well as sectors

- Case studies of existing users and possibly new adopters will help to expand our portfolio and provide qualitative and (hopefully) quantitative examples of how GPM data is supporting decision making as well as where we can improve
  - Share your story!

- We are always looking for suggestions, feedback, and new ideas!
  - Come to the working group meeting tomorrow!